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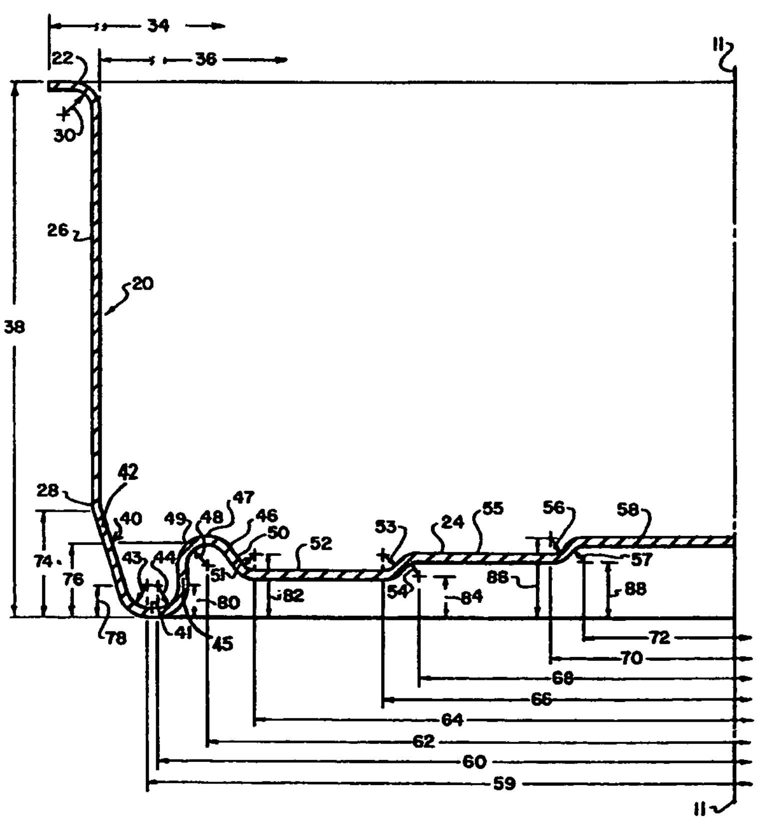
(71) Applicant
American Can Company, (USA—New Jersey), American Lane, Greenwich, Connecticut 06836-3610, United States of America
(72) Inventor
Gerald G. Echtermach
(74) Agent and/or address for service
Graham Watt and Co., Riverhead, Sevenoaks, Kent, TN13 2BN

(54) Buckle-resistant cans and a method of making them

(57) A sanitary can body 20 has a top-flanged side wall 26 integral with a profiled bottom wall 24, the latter meeting the side wall via a depending pressed peripheral rim 40. Inwardly of the rim 40 the bottom wall has an encircling countersink groove 46, two annular panel portions 52, 55 and a central panel portion 58. When profiling the bottom wall, the concentric panel portions 52, 55, 58 are placed in a state of tension by overstriking with first and second profile pads (96, 94, Figure 6), the second pad (94) being coaxially slidable within a punch sleeve (92) which initially forms the rim 40 by co-operation with the first pad (96).

FIG.3



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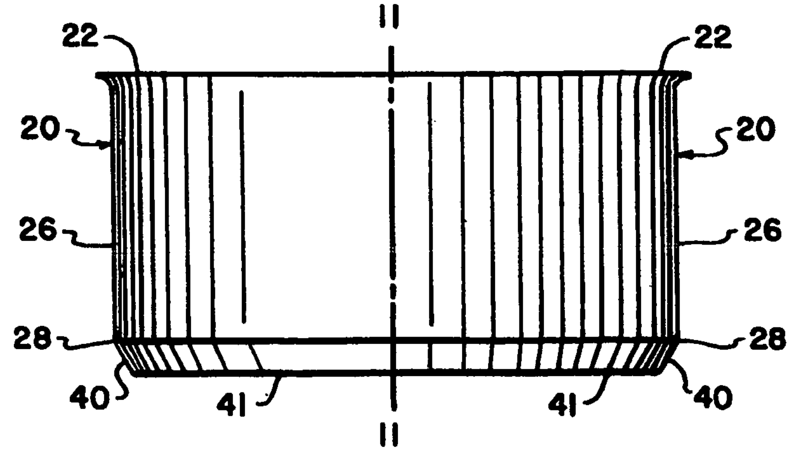
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FIG.1

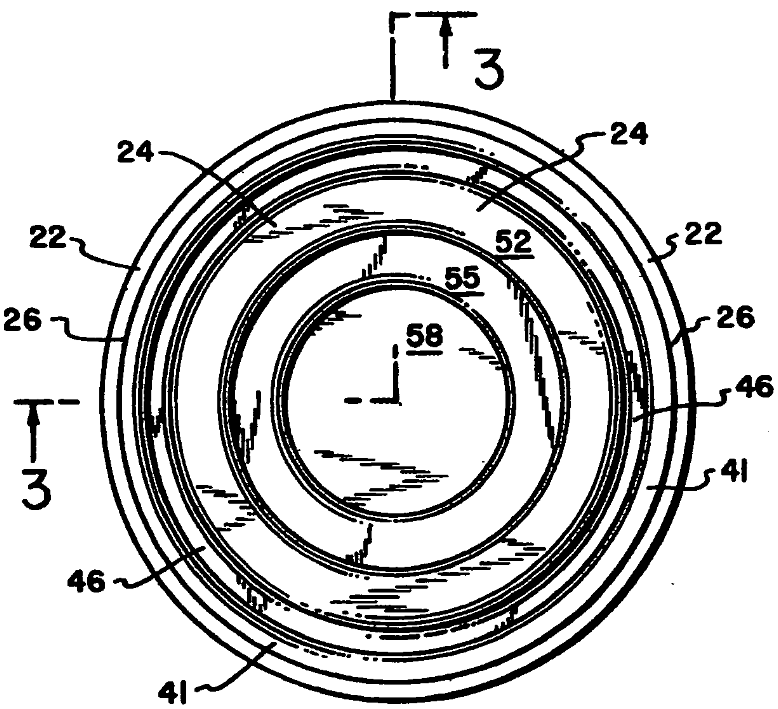
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FIG.2

FIG.3

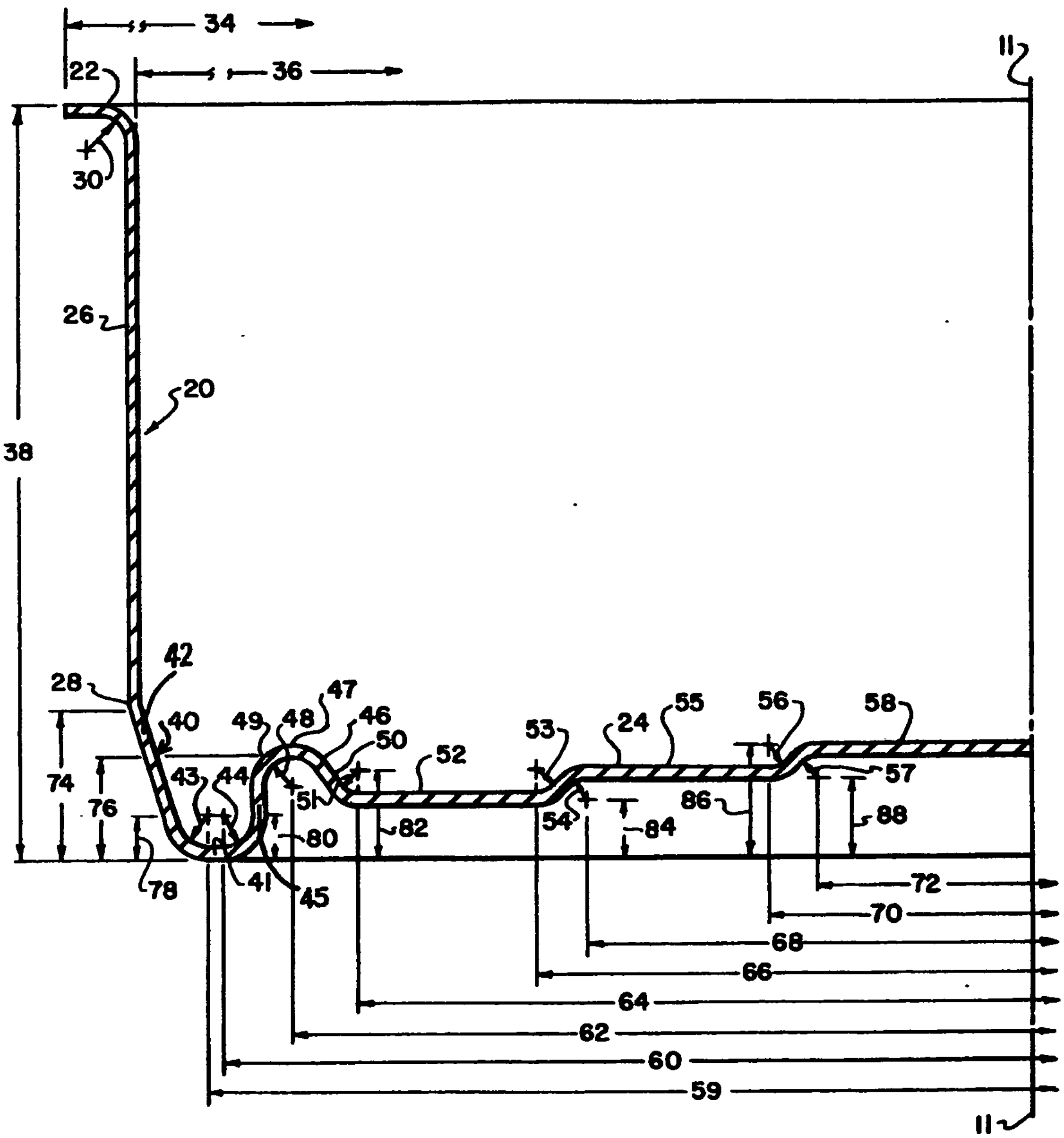
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FIG.4

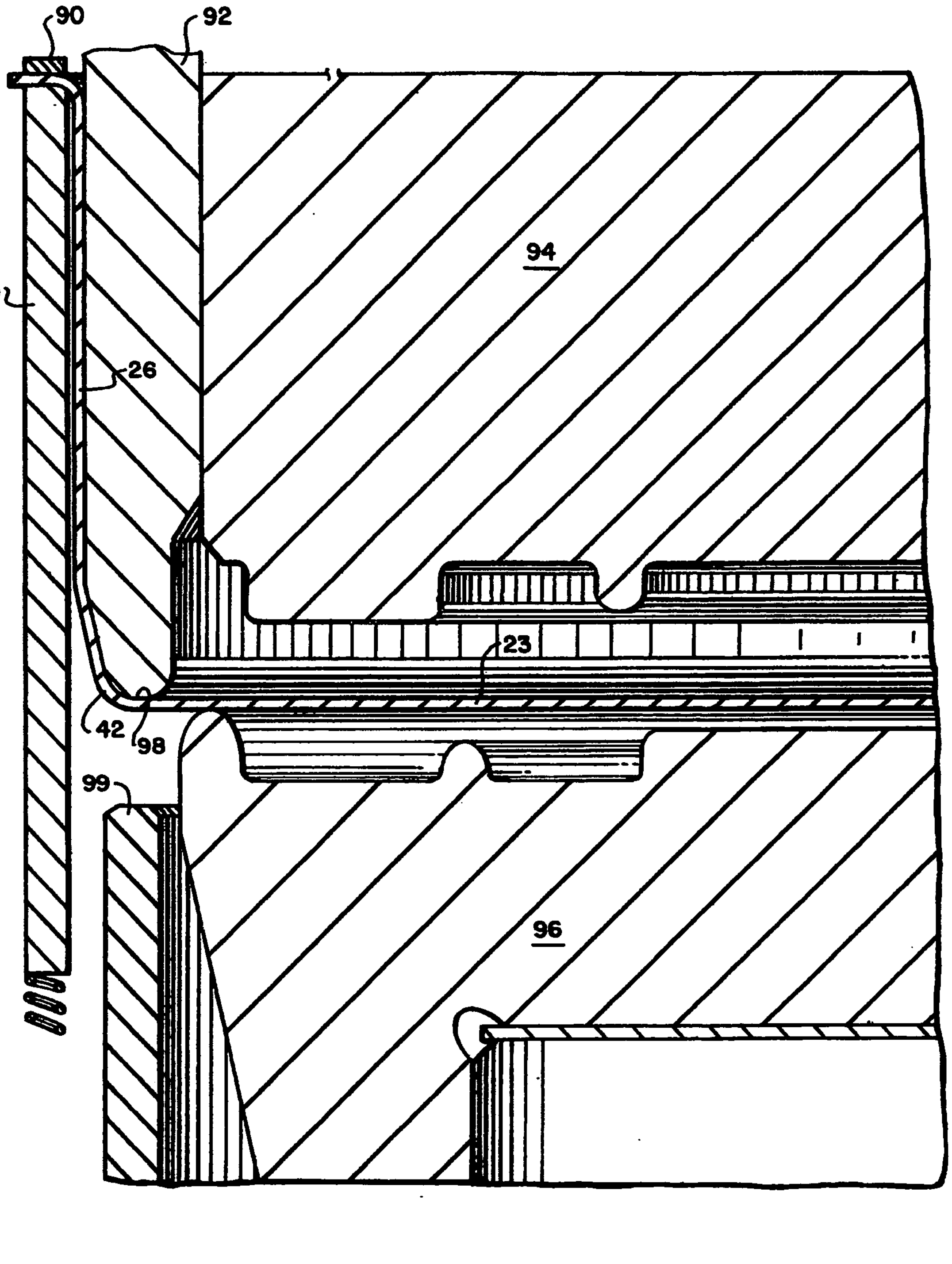

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FIG.5

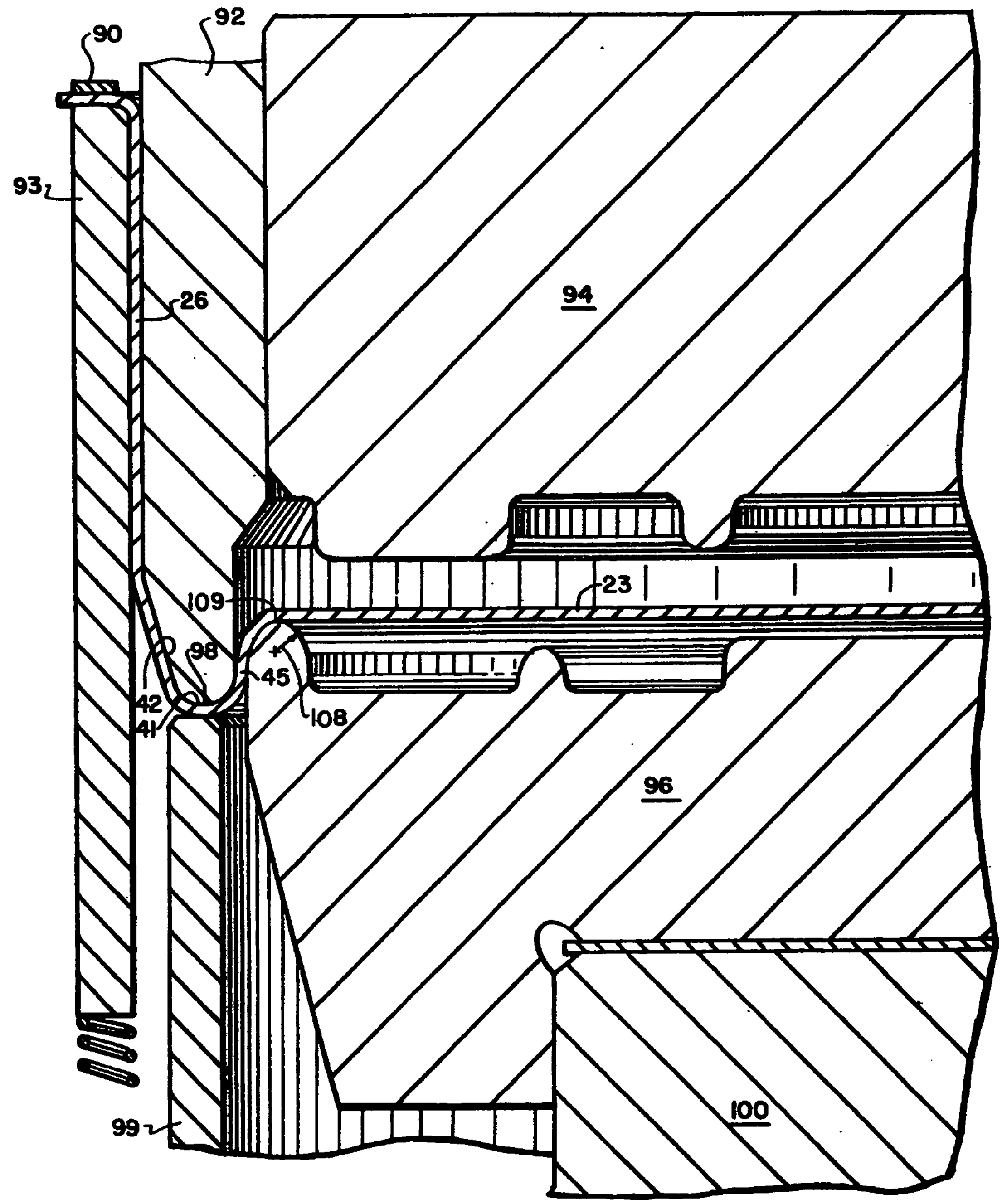

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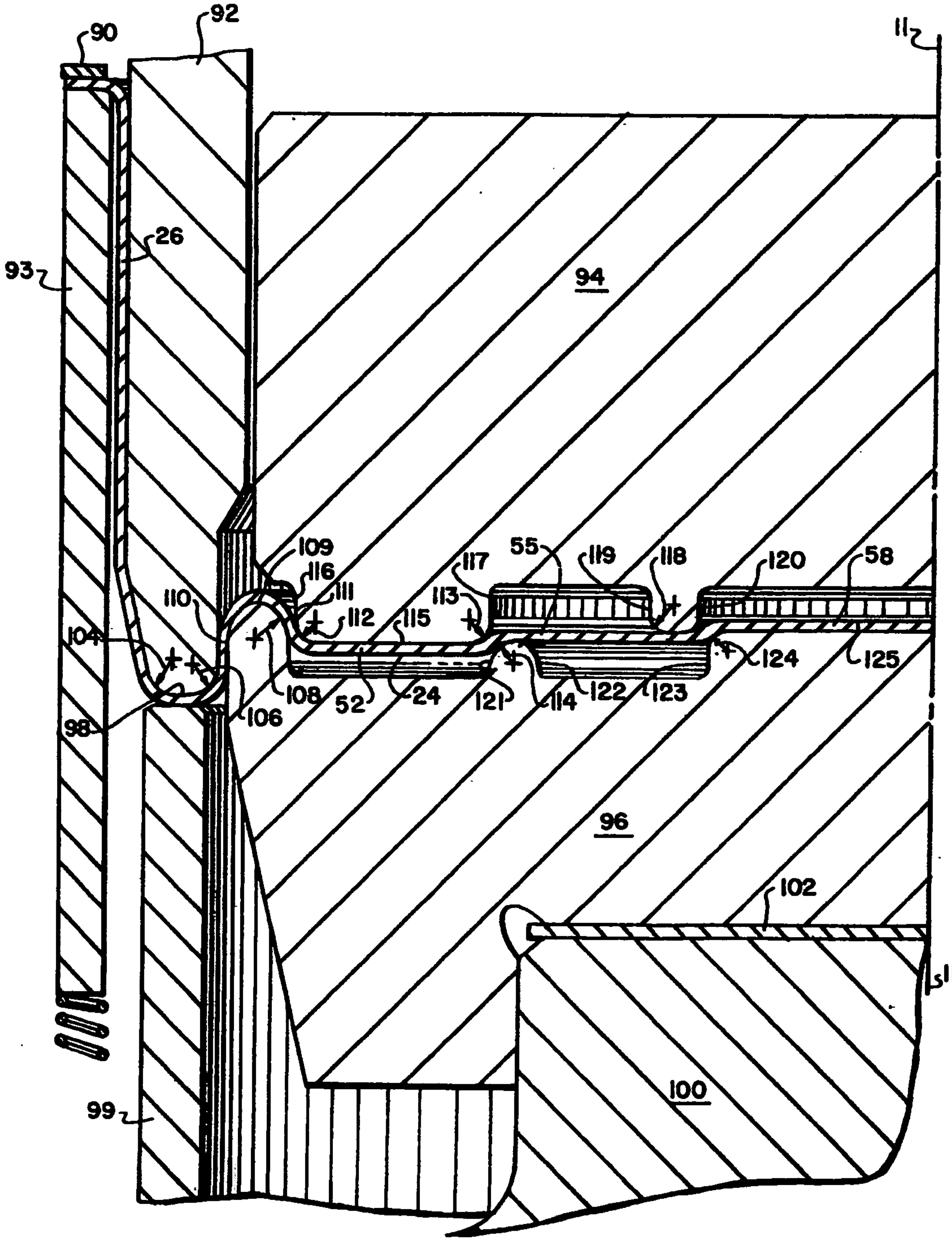
FIG.6



SPECIFICATION

Improved buckle-resistant cans and method of manufacture

This invention relates to improved buckle-resistant cans and method of manufacture thereof. More particularly the invention relates to sanitary cans where the bottom walls are integral with the side walls, as distinct from can bodies where the bottom walls are discs seamed or jointed to the cylindrical side walls. Such unitary cans, which find application as packages for a variety of food products, are manufactured by a draw/redraw process wherein steel strip is blanked, drawn and redrawn to form a basic container body. The basic container body is then flanged, contoured or profiled, trimmed and may even have the side wall strengthened by beading. The present application is directed to the contouring or profiling of the integral bottom wall of a container body to strengthen it and provide a stable configuration.

A major use of the drawn can is for the pet food market, where the can is packed at low vacuum and its contents are subjected to severe processing conditions. The can must be capable of withstanding the internal pressures developed during processing and pasteurization to avoid permanent distortion. That is, any distortion or bulging which occurs during the processing must be overcome by the springback or pullback properties of the can body when the can has cooled.

Permanent distortion is termed buckling. Such a condition is objectionable because it interferes with container stacking and even more so because it suggests that the container contents may be spoiled. Buckled cans are or may be unmarketable.

Buckling can occur at times other than during processing. For example, cans packaged with pet food at a United States West Coast cannery at sea level, and shipped over the Rocky Mountains to Denver, Colorado have been found permanently distended by the low atmospheric pressure encountered at the elevated altitudes during shipment.

This particular cannery has established a specification which calls for the can to resist buckling at internal pressures as high as 25 psi (1.7 bar) and to have springback retention wherein the can body returned to its original configuration when the internal pressures did not exceed 20 psi (1.4 bar).

While heavy plate such as 70 lb. plate will necessarily be strong enough and resistant enough to avoid permanent distention, use of such plate in making cans imposes an economic penalty which must ultimately be borne by the consumer. Plate characterised by weight in pounds is specified according to the can makers base box (B.B) measure. The quoted weight is that weight, in pounds, of 112 sheets each 14"x20". It is thus the weight of sheet or plate 31360 sq. inches in area, said sheet or plate being coiled or cut sheet form. 1 lb/BB equals 0.0224 kg/sq. m., so 70 lb plate is 1.57 kg/sq. m.

It is an object of this invention to provide a sanitary can body with an integral bottom wall which affords a high level of buckle resistance and springback retention when manufactured of high strength, light weight plate.

It is also an object of this invention to provide a method for manufacturing sanitary can bodies of light weight high strength plate which is compatible with conventional equipment and which ensures high levels of buckle resistance and springback retention are attained.

The invention may be embodied in a sanitary can body of the type having a peripheral outer flange at the top end of the can body, a cylindrical side wall symmetrical about an axis of rotation and joined to said flange, and a bottom wall integral with the side wall. A can according to the invention has a profiled bottom wall comprising a peripheral rim, an annular upwardly directed countersink groove, an annular outer panel, an annular midpanel and an inner panel.

The peripheral bottom rim is formed with an inwardly inclined outer rim wall, and inner rim wall, with said inner and outer rim walls converging to form the root of the rim. The rim root is substantially tangent to a base plane, which in turn is perpendicular to the axis of rotation. The inner wall of the rim is substantially perpendicular to the base plane.

The annular countersink groove is upwardly directed being adjacent to and inwardly disposed of the rim, the countersink groove is formed with a radius of curvature of .050" culminating at the crest of the groove. The outer groove wall merges with the inner rim wall.

The annular outer panel, is disposed inwardly of the countersink groove and concentric thereto. The panel lies in a plane parallel to the base plane. The plane of the outer panel lies between the base plane which is tangent to the root of the rim and a plane tangent to the groove crest. The outer panel is joined to the inner wall of the countersink groove by a fillet or concavity which has a radius of curvature of .035".

The annular midpanel is disposed inwardly of the outer panel, concentric and parallel thereto and lying on a plane between the plane of the outer panel and the plane tangent to the groove crest. The midpanel is joined to the outer panel by an ogee. The ogee consists of an outer fillet and an inner convergence each of which have a radius of curvature of 0.35".

The inner panel is disposed inwardly of the midpanel and parallel thereto and lies on a plane between the midpanel plane and the plane tangent to the crest of the groove. The inner panel is joined to the midpanel by an ogee with an outer fillet and an inner convergence each with a radius of curvature of 0.35".

The profiled bottom wall is preferably drawn taut and placed in tension so that the panels resist permanent distention.

A preferred sanitary can body is made of TFS—

CT (chromium treated tin free steel) which has been double reduced with a DR9 temper and having a plate weight of 60 lbs. per base box (1.34 kg/sq. m) and a plate thickness of 0.0066" (0.17 mm). A sanitary can manufactured by joining a closure to this sanitary can body has been found to resist buckling when subjected to internal pressures as high as 30—32 psi (2.1 to 2.2 bars). Further, it has been shown that when the internal pressure does not exceed 30 psi (2.1 bar) the can body will exhibit springback by returning to the original configuration when the internal pressure is released.

The integral bottom wall of the sanitary can body is profiled by receiving the unprofiled can body in a cushioned barrel which has a bore substantially equal to diameter to the external diameter of the finished can body, and wherein the flange of the can body is supported by the barrel. The flange is clamped to the barrel. A punch sleeve with an external diameter substantially equal to the internal diameter of the can is introduced into the can body so that the nose of the punch sleeve engages the peripheral of the bottom wall of the can body thereby forming the outer wall of the peripheral bottom rim. The invention will be described as if the portions of the tooling move independently. This is not essential to the satisfactory performance of the invention since some of the tool can move as a unit. The cushioned barrel and the punch sleeve are advanced carrying forward the clamped can body and causing the can body to engage a peripheral bead of a first or lower profile pad thereby completing formation of the bottom rim and pulling the planar bottom panel tightly across the crest of the peripheral bead. A second or upper profile pad, coaxially received within the punch sleeve, is than advanced to engage the tight planar bottom wall between the first and second profile pads thereby pulling the bottom wall over the peripheral bead to form the counter-sink groove and to initiate the forming of the outer panel, the midpanel and the inner panel. Further advancing the second profile pad to overstrike the bottom wall and thereby to fully set and define the countersink groove, the outer panel, the midpanel and the inner panel to tension the bottom wall and make the panel taut and flat. In another arrangement the upper profile pad and sleeve may move together as a unit when forming the end profile.

The invention will now be described in more detail by way of example only with reference to the accompanying drawings, in which:

Figure 1 is an elevational view of a sanitary can body with integral side and bottom walls,

Figure 2 is a plan view of the sanitary can body shown in Figure 1,

Figure 3 is an enlarged sectional view of the can body taken along the line 3—3 of Figure 2,

Figure 4 is an enlarged fragmentary cross sectional view through dies for profiling the bottom wall of the can body, the can body being shown mounted on a punch in position for paneling,

Figure 5 is an enlarged fragmentary cross sectional view through the dies for profiling the bottom wall of the can body, the can body being shown advanced by the punch sleeve so that the bottom wall is pulled tight, and

Figure 6 is an enlarged fragmentary cross sectional view through the dies, the bottom wall being shown fully engaged by upper and lower profiling pads whereby panels of which the bottom wall is composed are pulled taut and placed in tension.

Figures 1 and 2 of the appended drawings illustrate a sanitary can body embodying the present invention and comprising a cylindrical can body with a side wall an integral bottom, profiled to provide a stable configuration, resistant to buckling and with good springback retention. The can body has an open top provided with a peripheral flange so a can closure may be seamed to the body in a conventional manner. The can body is drawn from chromium treated tin free steel which has been double reduced with a DR9 temper and a 60 lb plate weight (1.34 kg/sq. m). The can body is employed for packaging under low vacuum food products, specifically pet foods. The can body can be of the 307×112 size, which is nominally $3^7/_{16}$" diameter and $1\frac{3}{4}$" tal. More exact dimensions—as referenced in Fig. 3—are: a flange diameter 34 equal to 3.500" (8.89 cm), an internal diameter 36 equal to 3.300" (8.38 cm) and a can height of 1.750" (4.44 cm). Merely by changing the diameter of the bottom innermost panel 58, it is possible to employ the configuration described for a wide range of can diameters.

The can body 20 has a side wall 26 which is inwardly inclined at its bottom end toward the base to form a peripheral rim 40 with a root 41 upon which the can body rests. The can body, which is symmetrical about a central axis of rotation 11—11 has a peripheral flange 22. The bottom wall 24 of the can body is profiled with a countersink groove 46, an outer planar panel 52, a planar midpanel (or intermediate panel) 55 and an inner or central planar panel 58.

For convenience, a one-quarter section of the can body is shown in Figure 3. It should be noted however, that dimensions 34, 36, 59, 60, 62, 64, 66, 68, 70 and 72 indicated in Figure 3 are diametrical distances rather than radial distances measured from the 11—11 axis.

The peripheral flange 22 of the can body 20 joins the side wall 26 with a convergence having a radius of curvature 30 of 0.050" (1.27 mm). A break in the side wall occurs at 28, 0.2" (5.1 mm) above the plane of the base of the container body to form the peripheral supporting rim 40. The outer wall 42 of the rim is inwardly inclined from the side wall 26. The outer wall 42 meets the inner wall 45 at the root 41 of the rim 40. The root is the location at which the plane of the base of the container body is effectively tangential to the rim 40. The outer wall 42 of the rim is formed

with a convergence meeting the root having a radius of curvature 43 equal to 0.044" (1.12 mm), with an origin or centre located a distance 78 equal to 0.051" (1.30 mm) above the base plane and on a circle with a diameter 59 equal to 3.128" (79.5 mm). The inner wall 45 of the rim 40 meets the root with a convergence having a radius of curvature 44 equal to 0.050" (1.27 mm) with an origin or centre located a distance 80 equal to 0.057" (1.45 mm) above the base plane and lying on a circle with a diameter 60 equal to 3.102" (78.8 mm). The inner wall 45 of the rim above the convergence is straight and substantially perpendicular to the base plane.

The countersink groove 46 is formed with a rounded apex or crest having a radius of curvature 48 equal to 0.050" (1.27 mm). The outer wall 49 of the groove 46 thereby merges smoothly with the inner wall 50 of the groove. The inner wall 50 of the groove thus meets the outer wall thereof at the crest 47 of the groove which lies a distance 76 equal to 0.150" (3.81 mm) above the base plane, and on a circle with a diameter 62 equal to 2.884" (73.3 mm). The origin of radius 48 necessarily also lies on a circle with a diameter 62.

A fillet with a radius of curvature 58 equal to 0.035" (0.89 mm) merges a planar panel 52 with the inner wall 50 of the countersink groove. The fillet has an origin, or centre, a distance 82 equal to 0.115" (2.9 mm) above the base plane and lying on a circle with a diameter 64 equal to 2.696" (68.5 mm). The planar panel 52 has a surface which is parallel to the base plane.

An ogee comprising a fillet with a radius of curvature 53 equal to 0.035" (0.89 mm) and a convergence with a radius of curvature 54 also equal to 0.035" (0.89 mm) merges outer planar panel 52 with planar midpanel 55. The origin of radius 53 is a distance 82 equal to 0.115" (2.9 mm) above the base plane and lies on a circle with a diameter 66 equal to 2.210" (56.1 mm). The convergence radius 54 has its origin a distance 84 equal to 0.069" (1.75 mm) and lies on a circle with a diameter 68 equal to 2.056" (52.2 mm). Planar panel 55 is parallel to the base plane.

An ogee comprising a fillet with a radius of curvature 56 equal to 0.035" (0.89 mm) and a convergence with a radius of curvature 57 also equal to 0.035" (0.89 mm) merges midpanel 55 with inner planar panel 58. The origin of radius 56 is a distance 86 equal to 0.143" (3.63 mm) above the base plane and lies on a circle with a diameter 70 equal to 1.566" (39.7 mm). The origin or centre of radius 57 is a distance 88 equal to 0.097" (2.46 mm) above the base plane and lies on a circle with a diameter 72 equal to 1.413" (35.9 mm). The inner panel 58 is parallel to the base plane.

Figures 4 to 6 illustrate tooling configurations and their use in manufacturing the above-described can body.

The can body is manufactured from precoated tin free steel (TFS-CT) plate which has been double reduced. The steel strip has a DR9 temper with a base box weight of about 60 lbs (1.34 kg/sq. m). DR9 is a mill product specification which relates to the process by which the metal is cold reduced in two stages with an annealing step between the cold working operations. The DR9 temper denotes a plate which is hard and which has a high tensile strength.

The preferred method of manufacture employs two presses. In the first press steel strip is blanked into a disc and subsequently drawn into a shallow cup of larger diameter. In the second press the shallow cup with a planar bottom is deposited on the end of a cylindrical barrel which has a bore diameter substantially equal to the external diameter of the finished can body. A punch with an external diameter substantially equal to the internal diameter of the finished can body enters the supported cup and pulls the cup down between the outer wall of the punch and the inner wall or bore of the barrel thereby redrawing the shallow cup into a can body of reduced diameter and increased height. At this point the bottom wall of the can body is still planar. Where the finished height of the can body is substantially greater than the cup height, it may be necessary to employ two redraw operations. This may be done by employing a single multi-station press as described in U.S. Patent 4,262,510. Alternatively a series of presses may be employed with the profiling and flanging being limited to the last press encountered by the body blank.

In accordance with the present invention the can body 20 is shown in Figure 4 after redrawing and in preparation for bottom profiling. As shown in Figure 4, the bottom wall at this point is still of planar configuration, the flange 22 is formed and is captured between the top wall of the press barrel 93 and a clamping ring 90. It should be noted that the barrel is cushioned by suitable means, typically a pneumatic cushion. The side wall 26 of the container body is shown captured between the cylindrical barrel 93 and the sleeve 92 of the punch. A nose 98 of the punch sleeve 92 at this point has engaged the bottom wall of the can body and formed the outer wall 42 of the peripheral rim 40 of the container bottom. The container body is moved downwardly by the advancing punch sleeve 92 and barrel 93 which operate in cooperation. An upper profile pad 94 of the punch is shown in a retracted position.

A lower profile pad 96 is proximate to the advancing can body and tooling but has not at this point been engaged thereby. A lift out and clamping device 99 is shown in a retracted position at this stage.

In Figure 5 the advancing punch and barrel have carried the can body forward to engage a peripheral bead 108 of the lower profile pad 96. Formation of the bottom rim 40 of the can body and the root 41 takes place as the nose 98 passes a crest of the bead 108 in the downward movement of the sleeve 92. The planar bottom 23 of the body is stretched tightly across the crest 109 of the bead. The root 41 of the rim, lying

between the outer rim wall 42 and the inner rim wall 45, is shown in contact with the upper surface of the lift out 99.

In Figure 6 the upper profile pad 94, which is coaxially received within the punch sleeve 92 is advanced to engage the tight planar bottom wall 23. As it advances, pad 94 pulls the bottom wall over the crest of the peripheral bead 108 to form the countersink groove 46 and to initiate the forming of outer panel 52, midpanel 55 and inner panel 58. The advance of the punch is further increased to effect an overstriking of the bottom wall by introducing a shim 102 between the lower profile pad 96 and die block 100 carrying same. This shim effects a 0.020" (0.51 mm) over-strike to accentuate the profile panels, place the panels in tension and make them taut.

In Figure 6, the upper profile pad is tightly radiused further to assist in tensioning the panels of the bottom wall. Thus, the peripheral bead of the lower profile pad 96 is formed with a radius of curvature 0.050" (1.27 mm) at 104 to form the outer bead wall 110, and at 106 to form the inner bead wall 111, these outer and inner walls meeting at the crest of the bead 109. The upper panel plate 115 is formed with corner radii 112 and 113 equal to 0.035" (0.89 mm). The plate walls 116 and 117 are substantially parallel to the axis of rotation 11—11 and therefore substantially perpendicular to the planar face of 115. A lower panel bead ring which shapes the junction between the outer and midpanels 52, 55, has a radius of curvature 114 equal to 0.035" (0.89 mm) and perpendicular side walls 121 and 122. An upper paneling bead ring or pad 94 is similarly formed with a radius of curvature 118 equal to 0.035" (0.89 mm) and with perpendicular side walls 119 and 120. This bead ring serves to form the junction between mid and inner panels 55, 58. The lower paneling plate of pad 26 which forms inner panel 58 is formed with a corner radius 124 equal to 0.035" (0.89 mm) and with a perpendicular side wall.

The clearance between perpendicular tooling surfaces 117 and 121 and between surfaces 120 and 123 is equal to the stock thickness plus about 0.0005" (0.01 mm), whereas the clearance between the inner wall of the peripheral bead defined by radius 108 and perpendicular wall 116 is about 0.0025" (0.06 mm).

The radial displacement between the origins or centres of radius 113 and radius 118 is 0.322". The radical displacement between the origins of radius 114 and 124 is 0.322" (8.2 mm).

Sanitary can bodies produced according to this method from TFS-CT steel double reduced to a DR9 temper, with a plate weight of only 60 lbs. per base box (1.34 kg/sq. m), have consistently resisted internal pressures of 30—32 psi (2.1 to 2.2 bars) without exhibiting buckling or permanent distortion. Further, these can bodies have shown good springback retention where the internal pressure has not exceeded 30 psi (2.1 bars), so that after subjection to such an internal pressure level, the bodies return to their original configurations. These capabilities enable the container to meet the customers' lower requirements of 25 psi (1.7 bar) buckle resistance and 20 psi (1.4 bar) springback retention with light weight plate despite the normal variations which may be encountered under production conditions.

Thus, it may be seen that the present method is able to produce a high strength can body, from light weight plate, which has a high level of buckle resistance and good springback retention. The body may be manufactured with tooling which is compatible with conventional apparatus.

While this invention has been described in relation to a 307x112 sanitary can for pet food it has been successfully employed for a variety of sanitary type cans including 300x405, 300x408 3/4, 301x106 and 307x200.25.

The detailed disclosure and the drawings show and explain the upper profile pad 94 and the sleeve 92 as moving independently with respect to one another, primarily for clarity in connection with the explanation of the invention herein. Those skilled in the art will no doubt appreciate that the movement of the upper profile pad 94 and the sleeve 92 can be simultaneous in order to facilitate the simplicity of the tooling design and construction. Likewise, other changes and modifications to the dimensions, shapes and structures can be included without departing from the scope of the appended claims.

Claims

1. A sanitary can body having an integral profiled bottom wall, which bottom wall comprises:

a. a peripheral rim formed by an inwardly-inclined outer rim wall and an inner rim wall, the lower extremities of the inner and outer walls converging to form a root of said rim which is substantially tangential to a base plane that is substantially perpendicular to a central axis of the body;

b. an annular, upwardly directed countersink groove adjacent to and inwardly of the rim, the countersink groove being formed with a radius of curvature of 0.050" (1.27 mm) and having a groove crest between radially outer and radially inner walls of the said groove;

c. an annular outer one of three panel portions disposed radially inwardly of the countersink groove and concentric therewith, the outer panel being parallel to the base plane, lying in a plane between the rim root and the groove crest, and merging with the groove inner wall via a fillet having a radius curvature of 0.035" (0.89 mm);

d. an annular middle panel portion disposed radially inwardly of the outer panel and concentric and parallel thereto, the midpanel lying in a plane located between the outer panel and the groove crest, and the midpanel merging with the outer panel via an ogee which has an outer fillet with a radius of curvature of 0.035" (0.89 mm) and an inner convergence with the same radius of curvature; and

e. an inner panel portion disposed inwardly of the midpanel, parallel thereto and lying in a plane between the midpanel and the said groove crest, the inner panel merging with the midpanel via an ogee which has an outer fillet with a radius of curvature of 0.035" (0.89 mm) and an inner convergence with the same radius of curvature.

2. A sanitary can body according to claim 1, wherein the bottom wall is taut and in tension so as to form a stable, distention-resistant configuration.

3. A sanitary can body according to claim 1 or claim 2, manufactured from TFS-CT grade steel, double reduced with a DR9 temper and a plate weight of 60 lbs. per base box (1.34 kg/sq. m.

4. A sanitary can body according to claim 1, 2 or 3, which has a cylindrical side wall extending from the bottom wall and terminating remote therefrom in an out-turned flange.

5. A sanitary can manufactured by joining a closure to the sanitary can body according to claim 4, and wherein said can bottom has a buckle resistance within the range 25—32 psi (1.7 to 2.2 bars) and a springback retention greater than 24 psi (1.65 bar).

6. A sanitary can body or a sanitary can incorporating the body, substantially as herein described with reference to and as shown in the drawings.

7. A method of profiling the bottom wall of a sanitary can body having a side wall, integral with the bottom wall, which presents an open top with a peripheral flange, the method comprising the steps of:

a. placing the can body in a cushioned barrel with its flange supported by the barrel;

b. clamping the flange to the barrel;

c. advancing a cylindrical punch sleeve into the can body to cause a nose of the sleeve to engage the periphery of the bottom wall and thereby form the outer wall of a bottom rim;

d. advancing the punch sleeve and the cushioned barrel to effect engagement of the clamped can body with a peripheral bead protruding from a first profile pad and thereby complete formation of the bottom rim and to pull the planar bottom panel tightly across the crest of the peripheral bead;

e. advancing a second profile pad coaxially received within the sleeve to engage the taut bottom wall between the first and second profile pads so as to pull the bottom wall over the said peripheral bead to form a countersink groove in the bottom wall and to initiate the forming of an outer panel, a midpanel and an inner panel in the bottom wall; and

f. overstriking bhe bottom wall with said second profile pad fully to set and define the countersink groove, the said outer panel, the said midpanel, and the said inner panel and to tension the bottom wall and tauten the said panels.

8. A method according to claim 7, wherein the tensioning of the bottom wall is facilitated by pulling the bottom wall around a tooling profiled radiused to 0.035" (0.89 mm) radius of curvature.

9. A method according to claim 7 or claim 8, wherein the bottom wall is pulled tight by use of a first profile pad wherein the peripheral bead thereof has a radius of curvature of 0.050" (1.27 mm).

10. A method of profiling the bottom wall of a container body having integral side and bottom walls, substantially as herein described with reference to Figs. 4 to 6 of the accompanying drawings.

11. A container body having a bottom wall profiled by the method claimed in any of claims 7 to 10.

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